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LINKING RIVER MANAGEMENT TO SPECIES CONSERVATION USING DYNAMIC LANDSCAPE-SCALE MODELS

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ABSTRACT

Efforts to conserve stream and river biota could benefit from tools that allow managers to evaluate landscape-scale changes in species distributions in response to water management decisions. We present a framework and methods for integrating hydrology, geographic context and metapopulation processes to simulate effects of changes in streamflow on fish occupancy dynamics across a landscape of interconnected stream segments. We illustrate this approach using a 482 km^2 catchment in the southeastern US supporting 50 or more stream fish species. A spatially distributed, deterministic and physically based hydrologic model is used to simulate daily streamflow for sub-basins composing the catchment. We use geographic data to characterize stream segments with respect to channel size, confinement, position and connectedness within the stream network. Simulated streamflow dynamics are then applied to model fish metapopulation dynamics in stream segments, using hypothesized effects of streamflow magnitude and variability on population processes, conditioned by channel characteristics. The resulting time series simulate spatially explicit, annual changes in species occurrences or assemblage metrics (e.g. species richness) across the catchment as outcomes of management scenarios. Sensitivity analyses using alternative, plausible links between streamflow components and metapopulation processes, or allowing for alternative modes of fish dispersal, demonstrate large effects of ecological uncertainty on model outcomes and highlight needed research and monitoring. Nonetheless, with uncertainties explicitly acknowledged, dynamic, landscape-scale simulations may prove useful for quantitatively comparing river management alternatives with respect to species conservation.

key words: aquatic biodiversity; freshwater fishes; hydrologic models; fluvial geomorphology; metapopulation dynamics

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